IS 10596-1 (1983): Code of practice for selection, installation, operation and maintenance of pumps for industrial applications, Part 1: Selection [MED 20: Pumps]

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Indian Standard

CODE OF PRACTICE FOR SELECTION, INSTALLATION, OPERATION AND MAINTENANCE OF PUMPS FOR INDUSTRIAL APPLICATIONS

PART 1 SELECTION

1. Scope — Intends to provide general guidelines for the selection of pumps for industrial applications.

1.1 This standard is not applicable to pumps for agricultural applications.

2. Selection — In the process of ordering a pumping unit the person concerned is required to identify system requirements. select the pump type, lay down the pump specification and develop all information necessary for the supplier.

2.1 *Fluid Characteristics* — Physical and chemical properties of the fluid to be handled, such as its viscosity, density, corrosiveness, lubricating properties, chemical stability, volatility, amount of suspended particles, etc, are of paramount importance in the process of selection of a pump. Depending upon the process and the system, some or all of these properties may have an important influence on pump and system design; for example, the degree of corrosiveness of the fluid will influence the material of construction, while if the fluid contains suspended solid particles, suitable type of pump seal designs, abrasion resistant pump construction material and type of impeller may have to be considered. The effect of change of temperature, pressure, time, etc, upon the fluid properties are also worth considering with regard to its possible effects on pump operation.

2.1.1 Generally the selection of a centrifugal pump is based on the water equivalent duties that is total head/effective head and volume rate of flow. Fluid characteristics should be considered while calculating water equivalent duties, for example, in case of viscous liquids head, capacity and efficiency is greatly affected and correction factors for these need to be considered. Reference should be made to IS : 5120-1977 'Technical requirements for rotodynamic special purpose pumps (*first revision*)' for such corrections. Similarly for liquids with consistancies more than 3 percent correction for head-capacity should be applied. Similar considerations need to be applied for liquids with solids. Proper correction should be applied for volume rate of flow depending upon solid percentage, nature and size of solids.

2.2 *Total Head* — A clear picture of the system, wherein the pumping system is expected to operate, should be kept in mind while calculating total head requirements. Since hydraulic losses are invariably present in the system due to pipe friction, bends and other fittings, due weightage should be given to these.

Based on the layout of the system and head losses, total head should be determined.

2.2.1 The NPSH requirement in case of centrifugal pump shall be based on water performance with on hydrocarbon correction factor. The NPSH required shall be based on 3 percent head drop.

2.3 *Volume Rate of Flow* — A pump is designed mainly on the basis of head requirements and required volume rate of flow. Hence exact requirements of volume rate of flow should be calculated.

2.4 *Alternate Mode of Operation* — The various modes of operation of the system are important considerations when specifying pumping unit.

The following parameter may be determined :

a) Operation of pump — continuous or intermittent,
b) Rate of flow or head — constant or flunctuating, and
c) Difference in flow and head requirements for different flow path.

2.4.1 These and many other questions arising from different modes of operation influence decisions regarding number of pumps and their volume rate of flow and need of booster pumps, to a great extent. To meet variable requirements of flow and head, number of pumps may have to be operated

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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in series or parallel. In such cases the effect of failure of one of the pumps shall also have to be considered as rated conditions for individual pumps shall abruptly change because of this and pumps may run on full open side beyond operating range of pump. The failure of pumping system may occur due to motor failure, power supply failure, and loss of control in electrical power, namely, frequency, voltage, etc. Hence proper importance should be given to these factors and occurrence of these causes should be evaluated beforehand as a part of selection of pump unit, especially the prime mover. The use of I.C. engines shall have to be considered.

2.5 *Wear* — Wear occurs in the system with a lapse of time causing operating characteristics to change. The extent of such wear over the life time of the equipment should be properly assessed and adequate margin provided in the system parameters so that the pump can render satisfactory service even up to the end of the use of the equipment. Where abrasive or suspended material particles are to be handled, pump with replaceable liners should be specified. These liners may be of resilient material, such as rubber compound or extremely hard alloys of cast iron. Plastic linings including those on impeller are also suitable for such services.

2.6 *Expected Future System Changes* — The requirements of future system changes should be incorporated taking into consideration the effect on performance of a pump due to its wear and tear if they can be predicted with any degree of certainity.

2.6.1 In any event, it should be kept in mind that the equipment must operate satisfactorily in the present system for which the pumping unit is being specified and this should be a factor in every evaluation being made.

2.7 *Selection of Pump* — The selection of the pump class and type for a particular application is influenced by such factors as system requirements, system layout, fluid characteristics, intended life, energy consumption, material of construction, code requirements, etc. The behaviour of the system greatly influences the choice of the basic type of pumps. Such as :

a) the required volume rate of flow and heads at different loads;

b) the effect of changes in volume rate of flow on system head;

c) the required head remain steady;

d) available NPSH; and

e) system details, such as :

   i) relief value,

   ii) surge chambers, and

   iii) expansion joints.

These are some of the parameters for which answers are to be found out.

2.7.1 *Pump characteristics*

2.7.1.1 Centrifugal pumps are considered suitable for variable-head, variable volume rate of flow applications.

2.7.1.2 Constant-speed reciprocating pumps find wide application in situations where the required volume rate of flow is expected to be constant over a wide range of system — head variations. This type of pumps is available in a wide range of design pressures, however the volume rate of flow is relatively small for the size of the equipment required.

2.7.1.3 While selecting a reciprocating pump, it should be kept in mind that the output from a reciprocating pump will be pulsating. Where this is objectionable, the use of rotary pumps may be made. However, the application of rotary pumps is limited to low-to-medium pressure ranges only, and are mostly recommended for handling oil and other viscous liquids.

2.7.1.4 It is to be noted that while rotary and reciprocating pumps are self-priming, centrifugal pumps are not, unless designed specifically. As reciprocating and rotary pumps are positive displacement type units, they will continue to build up excessive pressures on the delivery side if the discharge of liquid from them, while they are in operation, is restricted or stopped either by throttling or completely closing the gate valve in the delivey pipe line or if any other obstruction is produced

in the pipe for restricting or stopping the flow of the liquid. It is, therefore, always necessary to provide either an inbuilt type or a separate pressure-relieving or relief valve on discharge side of these pumps with arrangements to set them for opening at the desired pressures and by passing the flow back to suction.

2.7.1.5 In certain cases the system layout may have a very important bearing on the choice of pump type. Normally, centrifugal pumps require less floor space for installation than reciprocating pumps and vertical pumps less floor space than horizontal pumps. However vertical pumps may require more head room for maintenance and installation purposes.

2.7.1.6 Where the available NPSH is limited, such as when handling a saturated liquid, and the application calls for the use of centrifugal pump, the engineer may have to investigate the use of providing an inducer in place of the impeller nut in the case of end-suction pumps or a vertical canned-suction-type centrifugal pump to gain adequate NPSH. In certain other cases the design may call for the installation of a pump immersed in the liquid to be handled and hence, the use of a vertical submerged type pump may be advantageous.

2.7.2 *Code requirements* — The statutory codes of the regulatory bodies may impose certain additional requirements which can affect both pump rating and construction. Such additional requirements may affect the selection.

2.7.3 *Fluid characteristics* — Sometimes exceptionally severe service conditions based on fluid characteristics may rule out some classes of pumps at once. For example, the handling of fluids having high solid content will exclude the use of reciprocating pumps or pumps with close clearances. On the other hand, rotary-type pumps are suitable for viscous liquids and centrifugal pumps for both clean and clear fluids or fluids with high solid content. If it is undesirable for the process liquid to come in contact with the moving parts, diaphragam type pumps may have to be used. Centrifugal pumps are also suitable for handling viscous fluids and also handle liquids with solid contents.

2.7.4 *Material* — Materials of construction should be selected on the basis of service conditions. Indian Standards on various types of pumps, a list of which is given in Appendix A, give recommendations on suitable materials of construction.

Following main aspects should be considered while selecting the material of construction :

a) Liquid handled and its corrosion properties.
b) Solids present in the liquid and their abrasiveness and wear and tear due to that.
c) Temperature of liquid and effect of the same on corrosion rate of material and mechanical properties.
d) Maximum discharge pressure of the liquid in the casing, thickness of the casing and feasibility of casting the same.
e) Peripheral speed of the rotating parts.

2.8 *Selection of Prime Mover*

2.8.1 Selection of prime mover is as important as selection of the pump. Depending on the available energy sources, pumps may be driven by electric motor, I.C. engines, steam engines, gas turbines, steam turbines, etc. Also, they may be driven at constant speed or at variable speed.

2.8.2 Generally electric motors are used in constant-speed service unless a hydraulic coupling gear box or other speed varying device is introduced in the system for varying the speed. I.C. engines are chosen because of non-availability of power, portability or loss of power back-up requirements. Moreover they can operate as constant speed prime mover as well as variable speed prime mover. For variable speed applications, steam turbines, eddy-current couplings, adjustable speed motors, fluid couplings, gears and belts are frequently used.

2.8.3 In large complex installations where the equipment is to be operated continuously, the decision on the choice of the type of prime mover and variability of the pump speed should be based on the comparison of the total operating and capital costs for the pump system over the intended plant life for the several alternatives available. Variable speed operation would usually result in lower operating costs; however the total first cost of the driving equipment to accomplish this would frequently be higher than for constant speed pump.

2.9 *Specifying the Pump* — Reference may be made to the Indian Standards, a list of which is given in Appendix A.

APPENDIX A

(*Clauses* 2.7.4 *and* 2.9)

INDIAN STANDARDS ON PUMPS

IS : 1520-1980 Horizontal centrifugal pumps for clear, cold, fresh water (*second revision*)
IS : 1710-1972 Vertical turbine pumps for clear, cold, fresh water (*first revision*)
IS : 5120-1977 Technical requirements for rotodynamic special purpose pumps
IS : 5600-1970 Sewage and drainage pumps
IS : 5639-1970 Pumps handling chemicals and corrosive liquids
IS : 5659-1970 Pumps for process water
IS : 6536-1972 Pumps for handling volatile liquids
IS : 6596-1972 Pumps for handling paper stock
IS : 8034-1976 Submersible pumpsets for clear, cold, fresh water
IS : 8418-1977 Horizontal centrifugal self-priming pumps
IS : 8472-1977 Regenerative self-priming pumps for clear, cold, fresh water
IS : 9137-1978 Code for acceptance tests for centrifugal, mixed flow and axial pumps — Class C
IS : 9201-1979 Pumps for handling slurry

EXPLANATORY NOTE

In modern age pumps find a very wide field of applications, such as domestic water lifting, irrigation, fire fighting, hydraulic presses, hydraulic servosystems, mining, chemical and petroleum industries. For proper functioning and life of the pumps two requirements should be met with, namely :

a) proper selection of the type suitable to the working conditions; and

b) proper installation, operation and maintenance.

To deal with this situation effectively we will have to recognize the various factors responsible for the smooth and efficient working. This knowledge can be acquired only through long experience in the field and through investigations where required.

Old users can have the knowledge based on their long experience in the field while coming across various problems varying in nature. On the other hand new users without any guidelines find themselves helpless in making use of optimum life in the smooth functioning. Here point of paramount importance is the proper installation and maintenance of genuine pump selected for the purpose.

This code of practice has been prepared only with an intension to provide guidelines for the proper selection, installation, operation and maintenance of pumps excluding agricultural pumps.

This code is being issued in the following four parts for easy reference :

Part 1 Selection

Part 2 Installation

Part 3 Operation

Part 4 Maintenance

Reprography Unit, BIS, New Delhi, India